DP #487-78

INSTITUTE FOR RESEARCH ON POVERTY DISCUSSION PAPERS

SOCIAL STRUCTURE AND THE DIFFUSION OF MEDICAL INNOVATIONS IN THE UNITED STATES, GREAT BRITAIN, SWEDEN AND FRANCE

J. Rogers Hollingsworth
Jerald Hage
Robert Hanneman

UNIVERSITY OF WISCONSIN~MADISON

Social Structure and the Diffusion of Medical Innovations in the United States, Great Britain, Sweden and France

J. Rogers Hollingsworth
Jerald Hage
Robert Hanneman
University of Wisconsin-Madison

June 1978

This paper was prepared for presentation at the IX World Congress of Sociology in Uppsala, Sweden, August 14-19, 1978 at the session on crisis and change in industrialized nations. The research was supported in part by the Institute for Research on Poverty at the University of Wisconsin-Madison under funds granted by the Economic Opportunity Act of 1964 and administered by the Department of Health, Education, and Welfare. We also wish to acknowledge assistance from the National Science Foundation under Grant Number SOC 76-17318, the German Marshall Fund of the United States, and the Woodrow Wilson International Center for Scholars. We have benefitted from and are very grateful for the comments of Donn D'Alessio, Norman Fost, Rob Mare, George Pasdirtz, Guenther Risse, Aage Sørensen, and Sy Spilerman. Margaret Hedstrom and Quy Pham provided very valuable assistance in collecting and processing the data. The conclusions expressed herein are those of the authors.

ABSTRACT

This paper explores the relationship between (1) several structural characteristics--(the level of centralization of the health delivery system, the level of professionalization of the health delivery system, and the level of development of the society's communication system)--and (2) the diffusion of medical innovations in four countries: Great Britain, France, Sweden, and the United States during the period between 1880 and 1970.

The medical interventions included in this study were low cost and highly efficacious and thus were of greater value to low income groups than most other medical interventions which are less efficacious and more expensive. However, social structural variables influenced the rate at which these technologies diffused across countries. By focusing on the role of social structural variables in influencing diffusion rates, one can better understand why some societies benefit earlier than others from new technologies which have considerable benefit to low income groups.

The paper demonstrates that the theoretical literature on complex organizations and communications may be integrated in order to explain the diffusion of innovations at the societal level. The dependent variables are the rate at which innovations are adopted at the societal level and the speed with which innovations are implemented throughout the society once an innovation has been adopted.

To assess the rate of diffusion and the rate of implementaion of health innovations, the research focuses on highly efficacious vaccines and measures the rate of decline in the mortality of specific deseases once a vaccine has diffused to a particular country. The following

diseases were selected: smallpox, diptheria, tetanus, whooping cough, tuberculosis, polio, and measles.

Most of the data are obtained from official publications for each of the four countries.

Social Structure and the Diffusion of Medical Innovations in the United States, Great Britain, Sweden and France

This study poses the theoretical problem of how the structure of a society influences the diffusion of innovations.[1] There have been a large number of diffusion studies (see Zaltman et al. 1973; Katz et al. 1963; Hamblin et al. 1973), but there have been relatively few with a cross-national framework. There has often been a tendency in the within nation studies to emphasize certain values as important in influencing diffusion rates: examples are the cosmopolitans who quickly accept an innovation and the locals who are more slow to be part of a diffusion process (Merton 1957; Barnett 1953; Becker 1970; Mytinger 1968). If the nation-state is the unit of analysis, however, diffusion studies should focus on the role of social structure. And though there is a range of structural variation within nation-states, there are structural characteristics which differentiate nation-states.

The focus is on medical technology, predominantly, vaccinations. We have selected this type of medical technology for a variety of reasons. First, there is a comprehensive literature which suggests that certain characteristics of innovations (i.e., costs, efficaciousness, low-risk technologies) influence the diffusion process (Zaltman et al. 1973; Fliegel and Kivlin 1968). Because vaccines are not very costly, represent a low-risk technology, and are usually highly efficacious (Albritton 1978), we are able to hold these variables constant by focusing on the diffusion of this kind of medical intervention.

Second, there is scholarship suggesting that the values of elites affect differences in diffusion rates (Barnett 1953; Katz et al. 1963; Hage and Dewer 1973; Kaluzny et al. 1974; Rogers 1962). However, most everyone wishes to eliminate death and disease due to smallpox, diptheria, polio, whooping cough, and the like, and vaccines, of course, are designed to achieve this end. The pay-off for most types of innovations is less clear, however. Because most groups are receptive to the idea of vaccines, we are able to hold the values of elites and non-elites constant as we attempt to understand the diffusion process.

Third, the impact of vaccinations leaves a clear trace in declining morbidity and death rates, making retrospective study possible. And ideally, we wish to have longitudinal data in order to assess the changing interaction of our independent and dependent variables. Fortunately, the vast amount of cross-temporal and cross-national mortality data provide an excellent base for doing a test to analyze the impact of societal structure on the diffusion of medical interventions.

Why select the structure of society as a central analytical thrust? Despite the vast literature on diffusion, much of the sociological literature has emphasized attitudinal considerations (Rogers 1962). In addition, there has been recognition of the importance of communication. Indeed, this is often a hidden variable, along with the concept, reinforcement, which is analyzed in some depth in the seminal work of Hamblin et al. (1973). But we are still left without answers to what influences the particular patterns of communication and their volume and speed. Hopefully, this paper can advance the theoretical literature on diffusion at the societal level by integrating studies which emphasize communication in the diffusion process with other literature which is rarely referenced in the same study, mainly the work on innovations in complex organizations. The complex organizational literature has tended to emphasize such structural variables as centralization, size, and professionalization (Hage and Aiken

1970; Zaltman et al. 1973; Hage and Dewer 1973). One may synthesize these two intellectual streams by emphasizing the way in which the levels of professionalization and centralization influence the level, speed, and content of communication. By moving the organizational literature to a societal level of analysis, we provide a way of extending the literature on both communication theory and complex organizations.[2]

We propose to test the impact of social structure on the diffusion process of several carefully selected medical interventions representing different time periods during the past century in the United States, Sweden, France, and Great Britain. Despite the difficulty of obtaining precise measures from historical data, we have found considerable variation in the structural variables with four countries and ten decades. The specific medical interventions selected are for the following diseases: diptheria, measles, polio, tetanus, tuberculosis, smallpox, and whooping cough. To infer their diffusion across time and countries, we measure the decline of mortality from these diseases following the development of an efficacious medical intervention. The first section of the paper explicates the theory of social structure, while the second discusses the methodology and the data which we employ. We report our results in the third section.

1. A STRUCTURAL THEORY OF DIFFUSION

A central theme running through much of the diffusion literature deals with the nature of communication (Zaltman et al. 1973). Unfortunately, we know too little about the influence of social structure on communication. To relate communication to structure, it is useful to return to the small group of experiments of Bavelas (1950) whose insights indicated that we should be mindful of the distinction between communication networks and hierarchies which influence communication patterns. Other small group experiments have demonstrated that the free flow of communication is restricted by increasing the level of hierarchical differentiation (Leavitt 1951; Guetzkow and Simon 1955; Guetzkow and Dill 1957; Mulder 1960; Blau and Scott 1962). Building on the work of Bavelas and others, Hage (1974) demonstrated that communication networks in complex organizations are predictable on the basis of the organizations' degree of complexity and degree of centralization. We now wish to confront the problem of whether these same variables influence communication patterns at the societal level. Does the way that a health delivery system is organized for an entire society influence patterns of communication about health care, and therefore the nature and speed of the diffusion process?

In constructing a theory of structure and communication, it is important to recognize that we are reversing the causal direction from what has been the traditional way of conceiving of the issue. Bavelas and others seemed to believe that communication determined structure (Blau and Scott 1962, 126-28). Actually, a close examination of Bavelas' experiments indicates that he created the structures and then communication patterns developed within the existing structural context.

When one examines the theoretical literature relating structure and communication at the nation-state level, there is again the suggestion that communication influences a movement to decentralization (Lerner 1957, 1958; Deutsch 1953, 1963; Cutright 1963). And while we do not deny that there are long-term feedback effects between communication and structure, we wish to note that the level of centralization does influence the volume of communication. Indeed, the histories of many societies suggest that the more significant causal path is from structure to communication (Pye 1962; Apter and Rosberg 1959; Apter 1963; Fagen 1966). At any rate, our starting point is with how structure shapes and influences communication, and therefore influences the speed of diffusion.

Complexity, Communication, and Diffusion Processes

Perhaps the most direct way of approaching the question of communication is to confront the question of how much communication actually occurs. This was an important theme to emerge in the work of Rogers (1962). Similarly, Lerner (1958) and Cutright (1963) have demonstrated that there are substantial differences in the volume of communication between societies. Though there are assumptions underlying communication processes in much of the diffusion literature, the sheer volume of communication is usually not directly related to the speed of diffusion. An important exception, of course, is the study by Coleman et al. (1957) on the speed with which physicians adopted new drugs. Thus, our first hypothesis is simply:

1) The greater the volume of communication in society, the faster the speed of the diffusion of innovations.

Similar arguments for this have been made by Hamblin et al. (1973) and demonstrated by Coleman et al. (1957) and Rogers (1962). Unlike the previous literature, our work shifts these hypotheses to the societal level and argues that mass communications in and of themselves increase general awareness. Instead of confining our attention to medical personnel and analyzing only their communication network, our analysis assumes that communication must be disseminated from medical personnel to a much larger community and that the society's mass communications facilitate this exchange of information.

If one were to review the vast complex organizational literature on differential innovation rates, perhaps the single most consistent theme that one would observe is that increases in the degree of professionalization encourage more innovation (Zaltman et al. 1973; Hage and Aiken 1970). Thus Hage and Aiken (1967 and 1970) found that the greater the number of professional specialists, the higher the innovation rate. The level of professional activity also affects the rate of innovations: That is, the more that professionals attend meetings, present papers at professional conferences, and read the professional literature (i.e., the more that they communicate with other professionals), the higher the innovation rate (Crane 1972). The relationship between specialization and professional activity is so close that one might think of this as an index of communication among professionals.

Moch (1976) in his analysis of the diffusion of innovations among 489 American hospitals found that medical specialization was directly related to the number of adoptions. In a similar study among public health agencies and hospitals, Kalunzy et al. (1974) found that a professional orientation meant a higher rate of adoption of innovations.

In a re-analysis of the existing literature, Hage (1978) found that the concentration of professional occupations was strongly associated with innovations. An increase in the proportion of different specialities encourages interaction and competition (Burns and Stalker 1961) and therefore is a stimulus for innovation. This is also a theme which is consistent with the communication patterns of creative people (Pelz and Andrews 1966; Back 1962).

What is the relationship, however, between the innovation rate within organizations and the diffusion rate among organizations? Almost all of the evidence indicates that those organizations that adopt innovations first are also the ones that adopt the most innovations developed elsewhere (see Mohr 1976; Walker 1969; Rogers 1962). While the association is not perfect--there are naturally exceptions for specific historical reasons--it is strong enough so that one can make a reasonable inference about one from the other.

The theme running through this literature is that as an occupation becomes more professional, it specializes, (Stevens 1966, 1971; Somit and Tanenhans 1967; Greenwood 1964) and in the process, it engages in more communicative behavior (Crane 1972). The two go together (Hage 1974). Not only does communication lead to higher innovation rates and therefore faster diffusion rates, but the cause of this greater volume of communication adheres in the complexity of the social structure as measured by the density of professionals and the proportion of professionals engaged in specialized activities. In other words, the process of increasing professionalization and specialization encourages the generation of new knowledge via research (Crane 1972; Ben-David 1971). If the innovation is the development of a particular speciality within the larger profession, one would expect the presence of that speciality to act as a gate-opener into a communications network.

At the societal level, one finds the same theoretical arguments being made almost a century ago by Durkheim (1893 in the French edition) regarding the development of society. Increasing division of labor leads to greater organic solidarity which makes the society more adaptive. We are making the same point when we suggest that the complexity or the division of labor among physicians leads to greater communication which in turn leads to faster diffusion rates. Unfortunately, Durkheim's ideas have not been applied to the diffusion literature.

From this literature, we develop the following hypotheses:

2) The greater the professional density, the higher the volume of communication about medical care, and therefore the faster the speed of diffusion.

3) The greater the proportion of specialists among the professionals, the greater the volume of communication, and therefore the faster the adoption of innovations by a society and the faster the innovations are implemented throughout the society.

In health delivery systems, all of these variables influence knowledge about new technologies and therefore influence the speed with which they are adopted.

Changes in all these variables have occurred in the medical professions and the health care delivery systems of Western Europe and North America during the past century (Stevens 1966, 1971; Anderson 1972). The density of doctors relative to population has considerably increased, the proportion of physicians in a speciality has substantially increased since the end of the Second World War, and there has been a considerable increase in professional activities and in the amount of money and energy invested in medical and drug research. However, this trend towards structural differentiation (Hollingsworth 1971) has occurred at a different rate in each of our four countries. Therefore we have something approximating the conduct of a quasi-experiment at the timing of the causality is quite clear.

One can add a number of refinements to these various hypotheses relative to the way in which health delivery systems are organized. In Europe a large proportion of physicians are not allowed to practice in a hospital, and therefore one of the major avenues for integration into a communication network is denied (Abel-Smith 1964; Stevens 1966). In contrast, in the United States most physicians are affiliated with one or more hospitals and have considerable opportunity to keep abreast of current advances in the medical sciences. In some European countries, the state is much more involved in shaping health policy than in the United States (Anderson 1972; Abel-Smith 1965; Brand 1965). Recognizing that the degree of compulsion vs. cooperation varies between countries leads us to our next point, the impact of centralization on the diffusion process.

Centralization, Communication and Diffusion Processes

The argument relating centralization and communication to the diffusion process is a more complex one than that relating communication, professionalization and specialization to the diffusion process. A centralized system may be slow to adopt an innovation, but once a centralized system decides to adopt something, it can act more quickly than a decentralized system. This line of reasoning is supported in the original Bavelas (1950) study. The more centralized arrangements sent messages faster because the channels were shorter. Analogously, once a decision is made to innovate or adopt a new technology, this decision is more rapidly diffused throughout the health delivery system because all parts are connected by a hierarchical chain of command and a communication process that does not waste time.

On the other hand, the wheel communication networks (a more decentralized system) in Bavelas' experiments required more time.

Hage's (1974) study of communication in complex organizations indicates that the more centralized the decision-making in organizations, the more likely there is to be a hierarchy of communication rather than a "wheel type" network. In other words, the results of the Bavelas' experiments were found to have empirical reality in the larger world. Decentralized organizations fit the organic model, while centralized organizations approximate the mechanical model. Not only did the type of communication process vary, but also there was variation in the volume of communication. There was much more communication in the more decentralized networks, again supporting the Bavelas findings.

There is no consensus in the theoretical literature on the relation between centralization and innovation, however. In some of the complex organizational literature, there is the argument that one would expect faster adoptions of innovations in decentralized structures. In general, Aiken and Hage (1970) found this, thus confirming the earlier insight of Burns and Stalker (1961). Most of the literature on complex organizations tends to support the hypothesis relating centralization and the rate of the initial adoption of innovations but leaves unanswered the relationship between centralization and the speed of implementing innovations. Nevertheless, some scholars have argued that while centralization might retard the rate of innovations within an organization, it might speed up the rate of adopting or implementing others' innovations (Zaltman et al. 1973; Wilson 1966; Shepard 1967; Corwin 1969).

In some previously reported research findings, Hage (1978) noted that in some health and welfare organizations, centralization facilitated the adoption of others' innovations. This is most likely to occur when the organization is far behind others relative to the level of technology prevailing. A temporary higher rate of innovation then becomes a "catch-up." Centralized systems tend to wait longer to adopt innovations, but they implement changes more rapidly than decentralized systems.

In the political sociology and political science literature, the concern is not with the speed with which an innovation is widely implemented so much as with the rate with which innovations are adopted by cities or states. Aiken and Alford (1970) report that American cities with decentralized political structures tend to adopt innovations more rapidly than cities with centralized political structures, while Walker's (1969) study of American state governments, which spans some eighty years, found that more centralized states were more rapid in adopting new programs.

Indeed, the concern in most social science literature is generally with the rate at which innovations occur or are adopted but rarely with the speed with which innovations are implemented (Gray 1973; Aiken and Alford 1970). As we move from the concerns of complex organizations to a societal level of analysis, however, it becomes more important for us to consider the speed of implementing innovations because of the large number of local units involved. Thus, it is important to make the distinction between the speed of adoption and the speed of diffusion. These ideas can be summarized as follows:

4) <u>The greater the centralization, the less the volume of communication and the slower the decision to adopt a particular innovation</u>.

5) <u>The greater the centralization, the less the volume of communication and the slower the speed of adoption but the</u>

faster the implementation of the innovation once it is adopted.

Implicit in these hypotheses is the assumption that in a centralized and hierarchically arranged communication network, the key actors are "plugged in" and therefore once the decision is made to adopt an innovation, the message is effectively transmitted. In a more decentralized network, the message to adopt is likely to enter the network more quickly, but it takes a longer time to pass to all critical persons because it will go through a number of links, which increase the volume of communication but decrease the speed of diffusion. There follows from this the view that in a very decentralized health delivery system, the decision to use the new technology is made in the private sector with the individual consumer being a critical actor in the decision to accept or to reject the technology (Freymann 1974; Ward 1975; Alford 1975; Law 1974). In a highly centralized system, however, the central government is likely to mandate and to finance the use of the technology (Lindsey 1962; Stevens 1966; Mechanic 1972).

In summary, there are essentially two aspects of the structure of societies that affect the nature of the communication. The first is the density of professionals and the diversity of professional specialties in the delivery system. The second is the centralization of decision-making and of control. Together they influence the volume of communication, the way it is structured, and the speed with which messages are diffused. In turn these affect the speed of adoption and the speed of diffusion.

2. THE METHODOLOGY AND DATA

The data to be analyzed are neither time-points nor societies but instead what might be called disease-country experiences. Since we are concerned with the speed both of the adoption and of the diffusion of innovations and therefore with a continuous time period, our data are time series. These diffusion experiences can last only a few years, as in the case of polio, which experienced a rapid diffusion in all countries, or they can last for many years as in the case of diptheria (Rosen 1964; Parish 1968). The length of the experience can vary not only among diseases but also among countries. Thus our dependent variables relate to the amount of time required to complete the diffusion process. In turn, this raises several methodological problems that need to be considered.

The Nature of the Research Design

The essential idea is to approximate at least a quasi-experimental design (Campbell and Stanley 1966; Glass et al. 1975) at the nation-state level. Time series data were collected on an annual basis both prior to the development of an efficacious vaccine and afterwards so that one might measure (1) the lag between the time of the development of an innovation and its adoption in a country, and (2) the time between the adoption of an innovation in a particular country and its implementation in that country (this we have labeled the length of the diffusion process). Our analysis focuses on the impact of specialization, communication, and centralization on these two dependent variables. We focus on the impact of these structural variables on the dependent variables in four different countries--Sweden, the United States, France, and Britain--and over time in order to obtain variation in our variables. The over time analysis also increases the number of disease-country experiences or the number of observations. (See Table 1 for the list of disease-country experiences, the length of the time lag, and the time required for the implementation of a vaccine.)

There are, however, several conceptual problems that in turn create methodological difficulties. For example, the process of diffusion may span several decades. However, the structural variables do not remain constant during such a time span. Quite the contrary, they are changing a bit every decade, and in some decades, they change a great deal. Our solution to this problem was to code the structural variables for each ten year period, beginning with 1890, and then to use the scores in two different ways. The time-point immediately prior to the development of an innovation was used to describe the levels of centralization, communication, and specialization at the time of the innovation. This is useful for the analysis of the lag between the time of an innovation and the time that it is adopted by a country. But it is not very adequate for analyzing the time between the adoption of an innovation and the implementation of this innovation--especially if a long period of time were involved. To analyze the length of the diffusion process, we have computed the average for each of our structural variables for the entire span of years needed to complete the diffusion process. Together, these measures provide a means of testing our hypotheses relating structure to diffusion.

Another problem results from the fact that we have only an indirect measure of the diffusion process, as we make inferences about the diffusion

Table 1

Time Lag and the Length of Time Between the Adoption of an Innovation and Its Implementation for Each Country Disease Experience

Disease	U.S.A. Lag	U.S.A. Implementation	Great Britain Lag	Great Britain Implementation	France Lag	France Implementation	Sweden Lag	Sweden Implementation
Smallpox Mortality	0	1881–1929 48	0	1881–1904 23	0	1881–1929 48	0	1881–1895 14
Diptheria Mortality	0	1922–1954 32	14	1936–1952 16	8	1930–1958 28	0	1922–1950 28
Tetanus Mortality	0	1927–1964 37	0	1927–1954 27	NA	NA	1	1928–1955 27
Whooping Cough Mortality	0	1926–1959 33	1	1927–1959 32	4	1930–1970 40	0	1926–1954 28
Tuberculosis Mortality	0	1947–1966 19	0	1947–1966 19	0	1947–1973 26	0	1947–1967 20
Polio Mortality	0	1953–1964 11	0	1953–1964 11	6	1959–1971 12	0	1953–1962 9
Measles Mortality	4	1964–1968 4	5	1965–1972 7	0	1960–1970 10	0	1960–1964 4

of medical interventions from the observed changes in mortality data. We have focused only on those medical interventions for which we believe that the mortality data were reliable across the four countries and over time. At the same time, all of the decline in the mortality cannot always be attributed to the intervention of a vaccine (McKeown et al. 1975). For example, the decline in mortality resulting from diptheria was underway before the widespread utilization of a vaccine against diptheria (Rosen 1958, 1964). This resulted from the fact that improvement in living conditions--better sanitation, diet, housing, etc.--were probably responsible for some of the decline in mortality rates. This, of course, is often a problem in an experimental design, as a change in the dependent variable may be due to things other than the intervention on which one is focusing. By examining our data and by reading the medical histories of these four countries, however, we are hopeful that we can determine the dates at which the various countries began to use a health intervention.

Dating the end of the diffusion process--which ultimately determines the length of the process--is not as simple as it may first appear. The logic of an end point is the approach of some asymptote. But how does one define the correct asymptotic point? It is not the complete absence of deaths of disease cases. For most diseases, an end point with the complete eradication of a disease may never be reached (Top and Wehrle 1976; Hoeprich 1976; Youmans et al. 1975). For this reason, it seems more appropriate to speak of a steady state as a means of measuring the end of the diffusion process. The definition of a steady state for a particular disease is in part a function of the efficacy of the medical intervention and in part a function of the nature of the disease. For most diseases, we chose either five or ten deaths per million population as a reasonable steady state, but this was not possible with each disease experience.

We made an effort to select medical interventions which were spread throughout the period between 1890 and 1970, but for complex historical reasons, a number of the interventions were concentrated in the 1920s (diptheria and whooping cough) and the 1950s and 1960s (polio and measles). An exception is the smallpox vaccine which was developed before 1900 (Parish 1968).

Given the different rates of change in the independent and dependent variables, we have measured the latter on a yearly basis and the former for each decade. Our experience has demonstrated that structural variables change slowly (Rokkan 1970), whereas output variables such as mortality rates may fluctuate substantially in short periods of time (Keyfitz and Flieger 1971; Preston 1976). And to smooth the frequent fluctuations in mortality rates, we have presented our yearly rates as five year moving averages.

There are two exceptions in our data set. The smallpox vaccine was actually developed in the late eighteenth century, with some improvement in the vaccine taking place over a good bit of the nineteenth century. In the latter part of the nineteenth century, the vaccine was widely used in England and Wales, and for this reason, we date the 1880s as the starting point for the significant diffusion of the smallpox vaccine (Parish 1968). Tuberculosis represents the second exception in our data set. The French did develop a vaccine against tuberculosis during the 1920s, but it was not very efficacious and was hardly used outside France (Parish 1968). Thus, we have not incorporated the tuberculosis vaccine into our analysis. However, the mortality rates resulting from tuberculosis declined throughout the twentieth century--caused presumedly by a higher standard of living.

During the 1940s, however, a chemotherapy for the treatment of tuberculosis developed that was so efficacious that most authorities agree that no one receiving the treatment from tuberculosis should die (Johnston and Wildrick 1974). As a result, we have focused on the diffusion of the chemotherapy treatment for tuberculosis and have measured the length of time for the diffusion to occur by observing the decline in tuberculosis mortality once the treatment came into existence.

As we collected our data, one difficulty occurred. Mortality data were occasionally difficult to obtain for the period prior to World War II. In general, each country monitored certain diseases more carefully than others, as they did not always share the same set of concerns (Brand 1965; Rosenkrantz 1972). As a consequence, there are seldom data from four countries available for each disease (see Table 1).

The measurement of the structural variables presented fewer problems. We measured specialization or the complexity of the health delivery system with two indicators which were weighted equally.

(1) The number of physicians who were graduates of a medical school per 100,000 population (density).

(2) The proportion of physicians who limited their practice to a specialty.

We are not concerned merely with the communication among physicians or with communication between the government and physicians but with the nature of the entire society's communication system. Thus, we selected the number of telephone calls per person as the single most sensitive indicator of a society's communication.

We used two indicators for our measure of centralization, and we also weighted them equally. The first is the proportion of all revenue for medical purposes that comes from the central, the regional or local government, or from the private sector. Each of these proportions received a weight so that the greater the proportion funded by the central government, the more centralized the medical delivery system at that time-point (Hollingsworth and Hanneman 1978). Similarly, the greater the proportion of funding from the private sector, the less the level of centralization. The second indicator measures the level (central, regional or local government, or private sector) at which physicians are appointed to their positions. Here, our desire is to tap the level at which there is control over the providers of medical care. This is not a trivial distinction. Even though there has been considerable movement towards the centralization of the source of revenue because of increasing government involvement in the financing of medical care, there has not necessarily been an effort to control medical care personnel.

However, even if the theoretical arguments are validated concerning the relationship between the health delivery system and the diffusion process, the relationship might be spurious, due to variables which are exogenous to the health delivery system. Two such variables which may influence the timing of an adaptation of an innovation and the amount of time required to implement an innovation are the size of a country and its per capita income.

Size is an ubiquitous variable with often inconsistent results in social science literature (Hage and Aiken 1970; Dewar and Hage 1978; Downs 1976), and we would not expect it to influence the speed with which an innovation is adopted (lag). We would, however, expect that countries with large populations would be negatively associated with the time required to implement an innovation. The larger the country, the more difficult it is for information to be communicated throughout the population, and it is for this reason that more time is required for an innovation to be implemented in countries with large populations. There is considerable literature which demonstrates that the greater an organization's resources, the more innovative it is (Downs 1976). And we would expect that the higher a society's per capita income, the more quickly an innovation would be implemented. High levels of per capita income not only permit a society more easily to afford innovations but high levels of per capita income act as proxies for high levels of literacy and education--two variables which cause populations to demand highly efficacious medical interventions.

In summary, the analytical units are disease-country experiences. The differences in the scores of the structural variables across both time and space allow us to test their impact on the length and timing of the diffusion process.

Data

The mortality and population data for the four countries were gathered from official statistics over time in each country and from the United Nations publication, The Demographic Yearbook. For the United States, we relied heavily on The Historical Statistics of the United States and U.S. Bureau of the Census, Mortality Statistics. For Great Britain, the data were only for England and Wales and were collected from the annual report of the General Register Office, Statistical Review. The French data were from the annual reports of Annuaire Statistique de la France, and the Swedish from Historisk Statistisk för Sverige and Statistisk Årsbok.

The communication data are from B. R. Mitchell, European Historical Statistics, 1750-1970 (1975) and the Historical Statistics of the United States (1975). The major sources for medical professionalization were Rosemary Stevens, Medical Practice in Modern England (1966) and American

Medicine and the Public Interest (1971); Odin Anderson, Health Care: Can There Be Equity (1972); and the official census and medical directories in France, Great Britain, and the United States.

Centralization was a very complex variable to measure with data obtained from Dorothy P. Rice and Barbara S. Cooper, "National Health Expenditures, 1929-1970," Social Security Bulletin, Vol. 34, (January, 1971), 3-18; Anderson, Can There Be Equity (1972); Health and Personal Social Services Statistics for England and Wales (1973); and Hollingsworth and Hanneman's study on centralization (1978). For Sweden, valuable data were found in Wolfram Kock, Medicinalvasendat i Sverige; Medicinalstyrelsen, Allman Halso-och Sjukvardar 1917 (1920) and Allman Halso-och Sjukvard ar 1944.

3. FINDINGS

There are several issues which should be explored. First, one must ascertain whether in fact a diffusion process occurred. If the decline in mortality were linear, both before and after the adoption of an innovation, one would be unable to make an assumption as to whether or not there was the introduction of an efficacious medical technology. If the data revealed this trend, one might infer that the slow but progressive decline in mortality was due to the improvement in the standard of living. An examination of our data demonstrates that for some of the diseases, there was a long term decline in mortality before the introduction of a vaccine. But the data also demonstrate that once a country adopted the use of a highly efficacious vaccine, the rate of decline was much more steep. Therefore, we conclude that there was indeed a diffusion process.

A second issue is to assess the impact of the health delivery system variables (centralization, specialization, and communication) on (1) the delay in adopting an innovation, and (2) the amount of time it takes for the diffusion process to occur. A third task is to determine whether the relationships between the health delivery systems and the dependent variables are spurious, whether variables exogenous to the health delivery system are more satisfactory in explaining the rates at which innovations diffuse.

From Table 2, Part I, we observe from the zero order correlation coefficients that the predicted relationships among many of our variables are sustained. For example, the time required for an innovation to be implemented once it is adopted is negatively correlated with specialization (-.45), with centralization (-.47), and with communication (-.41). Moreover, we observe that specialization (.59) and centralization (-.18) have the predicted relationships with communication.

From the path model depicted in Figure 1, we also observe that the theoretical arguments hold up very well when we analyze the relationship between the health delivery system variables and the time required to implement innovations. The combined direct and indirect effects of specialization on the length of diffusion is -.42, that of centralization is -.45, and the net effect of communication is -.40. However, these relationships are somewhat modified when we assess the extent to which any of these relationships are spurious as a result of exogenous variables. In Figure 2, we observe that the size of the country and the per capita income of the country do influence the length of the implementation process: as expected, the higher the per capita income, the shorter the time required for implementation, while the larger the country, the slower the implementation process. Moreover, the impact of communication. centralization,

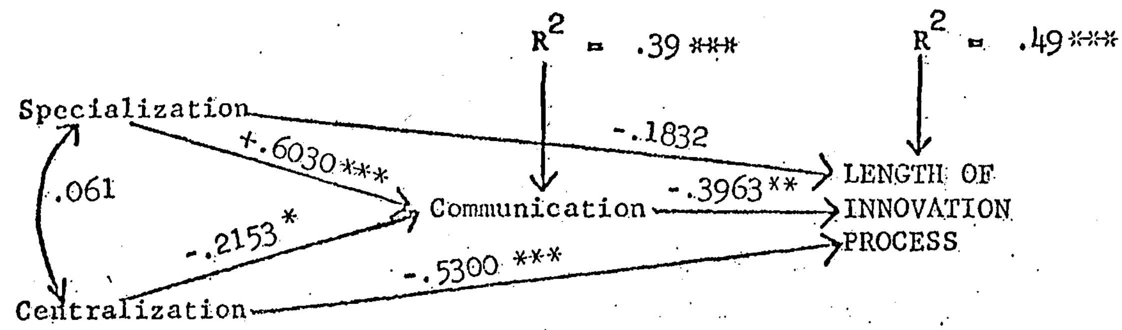
Table 2

Zero Order Correlations Among Innovations, Health Delivery System, and Exogenous Variables

	Variables During Implementation	Specialization	Centralization	Communication	Size	Income per capita	Time for implementation	Variables at Point of Adoption	Specialization	Centralization	Communication	Size	Income per capita	Lag
Part I: Variables during Implementation (N=27)														
Specialization		1.00												
Centralization		.06	1.00											
Communication		.59**	-.18	1.00										
Size		.74***	-.41*	.52**	1.00									
Income per capita		.88***	.00	.83***	.75***	1.00								
Time for Implementation		-.45*	-.47*	-.41*	.00	-.47*	1.00							
Part II: Variables at Point of Adoption (N=23)														
Specialization									1.00					
Centralization									.03	1.00				
Communication									.45*	-.07	1.00			
Size									.80***	-.40	.36	1.00		
Income Per Capita									.81***	-.02	.72***	.75***	1.00	
Lag									.04	-.10	-.21	-.02	-.04	1.00

Notes:

* = $p < .05$
** = $p < .01$
*** = $p < .001$



N = 27

Direct and Indirect Effects on Dependent Variable[@]

Variable	Net Effects
Specialization	-.42
Direct Effects -.18	
Indirect Effects -.24	
Centralization	-.44
Direct Effects -.53	
Indirect Effects .09	
Communication	-.40
Direct Effects -.40	

Notes:

* = $p < .1$
** = $p < .05$
*** = $p < .01$

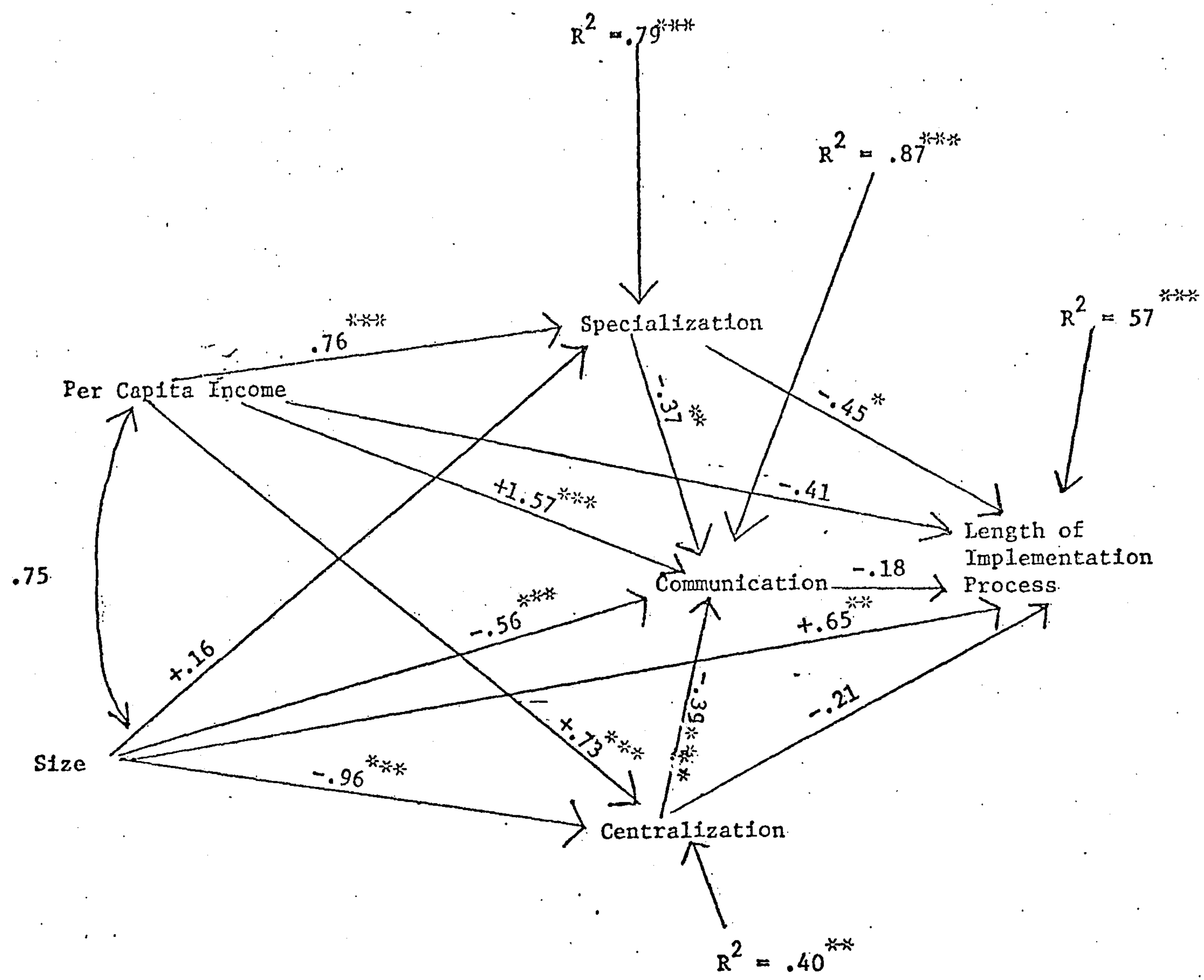
[@] See Duncan, 1966; Finney, 1972; Alwin and Hauser, 1974.

Figure 1. Path Model of Health Delivery System Variables on the Speed of Implementing Innovations

and specialization on the length of the diffusion process is reduced once both size and per capita income are introduced into the equation. When we decompose the relationships among the variables into their direct and indirect effects, we observe that per capita income and size of the country have net effects on the implementation process which are indeed very robust: They are the most powerful variables influencing the length of time required to implement innovations. Nevertheless, high levels of centralization, communication, and specialization--when controlling for the exogenous variables--continue to be associated with less time required for the implementation of innovations whether we examine their direct or net effects. Thus the basic theoretical arguments are supported.

On the other hand, the data provide mixed support for our hypotheses concerning the relationship between health delivery system variables and the time intervening between a discovery and the decision to adopt it (lag time) in a particular country. In Figure 3, we observe that increasing professionalization leads to better communication. Furthermore, an increase in communication means that less time is required for an adoption to occur--as the hypotheses suggest (see Table 2, Part II). However, centralization, in this model, has virtually no impact on communication or on the amount of time required for the adoption of an innovation. Moreover, specialization is positively rather than negatively associated with the amount of time required for the adoption of an innovation.

We do not entirely understand why Figure 3 does not provide better confirmation for our hypotheses concerning the time required between an innovation and its first adoption in a country. However, we believe that the problems lie more with the data than with our hypotheses. Our



Notes:

* = p < .1
** = p < .05
*** = p < .01

Figure 2. Path Model of Per Capita Income, Size of Country, and Health Delivery System on the Speed of Implementing Innovations

Table 3

Decomposition of Path Analytic Effects on the Speed of Implementing Innovations*

			Net Effects
Centralization			
Direct effects	-.21		-.14
Indirect effects	+.07 (via communication)		
Specialization			
Direct effects	-.45		-.38
Indirect effects	+.07 (via communication)		
Communication			
Direct effects	-.18		-.18
Income per Capita			-1.09
Direct effects	-.41		
Indirect effects	-.68		
via communication		-.29	
via specialization-communication		+.05	
via centralization-communication		+.05	
via centralization		-.15	
via specialization		-.34	
Size	—		+.82
Direct effects	+.65		
Indirect effects	+.17		
via communication		+.10	
via specialization-communication		+.01	
via centralization-communication		-.07	
via centralization		+.20	
via specialization		-.07	

Notes:

*See Duncan 1966; Finney 1972; Alwin and Hauser 1974.

data set provide very little variation in this particular dependent variable. An examination of Table 1 reveals that most innovations diffused very quickly. Indeed, more than two thirds of the innovations were adopted in less than one year. Overall, the mean time required for all innovations to be adopted by the four countries was 1.65 years. More importantly, it is very different to code the exact timing of the introduction of a medical intervention in a particular country. We have carefully consulted numerous histories and medical journals, and there is much contradictory evidence concerning the precise timing for the decision to use some vaccines.

In sum, our data provide rather firm support for our hypotheses concerning the relationship between health delivery systems and the time required to implement an innovation once the decision is made to adopt it. On the other hand, we believe the data are not adequate to support or disconfirm our hypotheses concerning the relationships between the health delivery variables and the time required to adopt an innovation once it has come into existence.

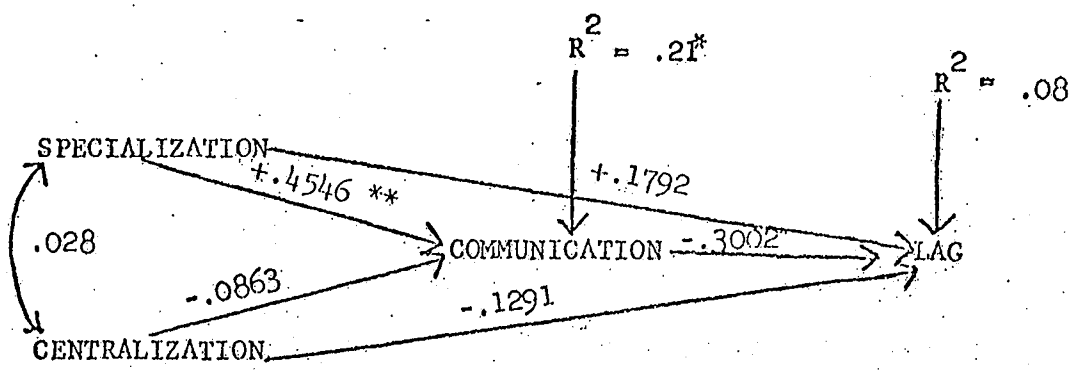
Concluding Comments

There are several observations which we would like to make about the above discussion:

First, we believe that the relationships between our independent and dependent variables would have been more robust had we a more direct measure of our dependent variable. Though we were focusing on the diffusion of medical interventions across societies, our measure of the extent of the diffusion process was most indirect: mortality rates attributable to specific infectious diseases. Ideally, we would have preferred to have had data on the percentage of the population which actually received specific medical interventions. However, it is only in very recent years that somewhat systematic data of this type have become available for a number of western countries.

Second, as Hamblin et al. (1973) suggest in The Mathematics of Social Change, one of the first issues to confront in the study of the diffusion is to determine the nature of the curve describing the process. We carefully examined the data and concluded that the diffusion process encountered here was a negative logistic diffusion process. Once we made this determination, we regressed the slopes of the negative logistic curve on our independent variables, as Griliches (1957) did in his classic article on hybrid corn some years ago. The results of this methodology were unsatisfactory however, for one basic reason: The fits for our negative logistic curves were poor. As the mortality rates declined, there were occasional epidemics, causing the direction of the curve to be temporarily reversed. And it was this irregular decline in the mortality rates which provided both poor fits for our curves and poor results when the slopes of the negative logistic curve were regressed on our independent variables. And it is for this reason that we employed the methodology presented above.

Third, there has been during the twentieth century, a convergence among the highly industrial countries of the world in the levels of centralization, specialization, communication--though at any point in time variation in these variables persists. Because there is movement toward convergence among these variables, there has been a considerable reduction in the lag time between an innovation and its adoption as well as the time required



N = 23

Direct and Indirect Effects on Dependent Variable[@]

Variable	Net Effects
Specialization	.04
Direct Effects .18	
Indirect Effects -.14	
Centralization	-.10
Direct Effects -.13	
Indirect Effects .03	
Communication	-.30
Direct Effects -.30	

Notes:

* = p > .1
** = p > .05
*** = p > .01

[@]See Duncan 1966; Finney 1972; Alwin and Hauser 1974.

Figure 3. Path Model of Health Delivery System Variables on the Time Required for the Adoption of an Innovation (Lag)

for the diffusion of a medical intervention in a particular country once it has been adopted (Meyer 1975). By 1900, the knowledge existed for the active immunization of populations against diptheria. But is was two decades before the vaccine could be developed and refined sufficiently for effective use. Therefore, it was not until 1920 that the widespread immunization against diptheria began (Rosen 1958, 1964), but even then, the time required for the total elimination of diptheria was considerable. By the 1950s, however, the level of knowledge and communication had increased so much that the polio vaccine diffused across the four countries with considerable speed and with cotinued increases in knowledge and communication, we would expect similar types of medical interventions to diffuse even more rapidly.

Fourth, several of our hypotheses, which synthesize some of the literature on communications and complex organizations, are validated at the societal level. We find that structure does indeed influence the rate of diffusion. The impact of the structural variables is stronger on the speed of diffusion rather than on the speed of adoption. In part, this may result because of the difficulty of always determining the year when an innovation occurred or when it was adopted. Of the three structural variables, communication and specialization appear to be the most important, with centralization having less impact.

The results are quite consistent with the complex organizational literature. And perhaps this is the most significant finding. The same hypotheses that appear to work for complex organizations apply to the nation-state level. The same processes seem to be involved, and one can quite successfully combine the communication and complex organizational literature into a single coherent theory of change involving innovation and diffusion (Hollingsworth and Hage 1974).

NOTES

[1]The other social sciences have their own traditions of handling innovations. Examples of the economics literature are: J. Schmookler, Invention and economic growth (Cambridge: Harvard University Press, 1966); Edwin Mansfield, Technical change and the rate of imitation, Econometrica, XXIX (1961), 741-66; Industrial research and technological innovation--An econometric analysis (New York: Norton, 1968); The economics of technological change (New York: Norton, 1968). Some of the anthropological perspectives are discussed in: Robert Redfield et al., Memorandum on the study of acculturation, American Anthropologist, XXXVIII (January-March, 1936), 149-52; Munro S. Edmondson, Neolithic diffusion rates, Current Anthorpology, II (1961), 71-102. For the political science literature, see George W. Downs, Bureaucracy, innovation, and public policy (Lexington, Mass.: D.C. Heath and Co., 1976).

BIBLIOGRAPHY

Abel-Smith, Brian. 1964. The hospitals, 1800-1948. London: Heinemann.

Abel-Smith, Brian. 1965. The major pattern of financing and organization of medical services that have emerged in other countries. Medical Care. 3:33-40.

Aiken, Michael and Robert Alford. 1970. Community structure and innovation: The case of public housing. American Political Science Review. 64:643-864.

Albritton, Robert B. 1978. Cost-benefits of measles eradication: Effects of a federal intervention. Policy Analysis. 4:12.

Alford, Robert R. 1975. Health care politics: Ideological and interest group barriers to reform. Chicago: University of Chicago Press.

Alwin, Duane F. and Robert M. Hauser. 1974. The decomposition effects in path analysis. Discussion Paper, 74-33. Center for Demography and Ecology, University of Wisconsin-Madison.

Anderson, Odin. 1972. Health care: Can there be equity? The United States, Sweden, and England. New York: John Wiley and Sons.

Apter, David E. and Carl G. Rosberg. 1959. Nationalism and models of political change in Africa. In Donald P. Ray, ed., The political economy of contemporary Africa. Washington, D.C.: The National Institute of Social and Behavioral Science, 1959.

Back, K. H. 1962. The behavior of scientists: Communication and creativity. Sociological Inquiry. 32:82-87.

Barnett, Homer G. 1953. Innovation. New York: McGraw-Hill.

Bavelas, Alex. 1950. Communication patterns in task-oriented groups. The Journal of the Acoustical Society of America. 22:725-730.

Becker, M. 1970. Sociometric location and innovativeness: Reformation and an extension of the diffusion model. American Sociological Review. 35:267-282.

Ben-David, Joseph. 1971. The scientist's role in society: A comparative study. Englewood Cliffs, N.J.: Prentice-Hall, Inc.

Blau, Peter. 1973. The organization of academic work. N.Y.: John Wiley and Sons.

Blau, Peter M. and W. Richard Scott. 1962. Formal organizations: A comparative approach. San Francisco: Chandler Publishing Co.

Brand, Jeanne L. 1965. Doctors and the state. Baltimore: The Johns Hopkins Press.

Burns, Tom and G. M. Stalker. 1961. The management of innovation. London: Tavistock Publications.

Campbell, Donald T. and Julian C. Stanley. 1966. Experimental and quasi-experimental designs for research. Chicago: Rand McNally and Co.

Coleman, James S., Elihu Katz and Herbert Menzel. 1957. The diffusion of an innovation among physicians. Sociometry. 20:253-269.

Corwin, Ronald. 1969. Patterns of organizational conflict. Administrative Science Quarterly. 14:507-522.

Crane, Diana. 1972. Invisible colleges: Diffusion of knowledge in scientific communities. Chicago: University of Chicago Press.

Cutright, Phillips. 1963. National political development: Measurement and Analysis. American Sociological Review. 28:253-264.

Deutsch, Karl W. 1953. Nationalism and social communication. New York: John Wiley and Sons.

Deutsch, Karl W. 1963. The nerves of government. New York: The Free Press of Glencoe.

Dewar, Robert and Jerald Hage. 1978. Size, technology, complexity, and structural differentiation: Toward a theoretical synthesis. Administrative Science Quarterly. 23:111-136.

Downs, George W., Jr. 1976. Bureaucracy, innovation, and public policy. Lexington, Mass.: D.C. Heath and Co.

Duncan, Otis D. 1966. Path analysis: Sociological examples. American Journal of Sociology. 72:1-16.

Durkheim, Emile. 1893. Division du travail social. Paris: Agienne Librarie Gernes Bailliere Co.

Fagen, Richard R. 1966. Politics and communication. Boston: Little, Brown and Co.

Finney, John M. 1972. Indirect effects in path analysis. Sociological Methods and Research. 1:175-186.

Fliegel, F. C., J. E. Kivlin and G. S. Sekhon. 1968. A cross cultural comparison of farmers' perceptions of innovations as related to adoption behavior. Rural Sociology. 33:437-449.

Freymann, John G. 1974. The American health care system: Its genesis and trajectory. New York: Medcom Press.

Glass, Geve V., Victor L. Willson and John M. Gottman. 1975. Design and analysis of time-series experiments. Boulder, Colorado: Colorado Associated University Press.

Gray, Virginia. 1973. Innovation in the states: A diffusion study. American Political Science Review. 67:1174-1185.

Greenwood, Glen. 1964. Specialization in the medical and legal professions. Mundelein, Illinois: Callagan.

Griliches, Zvi. 1957. Hybrid corn: An exploration in the economics of technological change. Econometrica. 25:501-522.

Guetzkow, Harold and Herbert A. Simon. 1955. The impact of certain communication nets upon organization and performance in task oriented groups. Management Science. 1:233-250.

Hage, Jerald. 1978. An integration of complex organizational theory. Forthcoming.

Hage, Jerald. 1974. Communication and organization control. New York: John Wiley and Sons.

Hage, Jerald and Michael Aiken. 1967. Program change and organizational properties: A comparative analysis. American Journal of Sociology. 72:503-519.

Hage, Jerald and Michael Aiken. 1970. Social change in complex organizations. New York: Random House.

Hage, Jerald and Robert Dewer. 1973. Elite values versus organizational structure in predicting innovation. Administrative Science Quarterly. 18:279-289.

Hamblin, Robert L., R. Brooke Jacobsen and Jerry L. L. Miller. 1973. A mathematical theory of social change. New York: John Wiley and Sons.

Hoeprich, Paul D. 1976. Infectious diseases: A modern treatise of infectious processes. New York: Harper and Row.

Hollingsworth, J. Rogers. 1971. An approach to the study of comparative historical politics. In J. Rogers Hollingsworth, ed., Nation and state building in America: Comparative historical perspectives. Boston: Little, Brown and Co.

Hollingsworth, J. Rogers and Jerald Hage. 1974. Social costs and benefits of health and educational policies in four western countries. Unpublished paper presented before the American Historical Association, December, 1974.

Hollingsworth, J. Rogers and Robert Hanneman. 1978. Centralization in health and education delivery systems: The British and American experience. Unpublished paper presented before the American Political Science Association, September, 1978.

Johnston, Robert F. and Kenneth H. Wildrick. 1974. "State of the art" review. The impact of chemotherapy on the care of patients with tuberculosis. American Review of Respiratory Disease. 109:636-664.

Kaluzny, Arnold D., James E. Veney and John T. Gentry. 1974. Innovation of health services: A comparative study of hospitals and health Departments. Milbank Memorial Fund Quarterly. 51-82.

Katz, Elihu, Herbert Hamilton and Martin Levin. 1963. Traditions of research on the diffusion of innovation. American Sociological Review. 28:237-252.

Keyfitz, N. and W. Flieger. 1971. Population: facts and methods of demography. San Francisco: W. H. Freeman.

Kock, Wolfram. 1963. Medicinalrasendet i Sverige, 1813-1962. Stockholm: Nordiska Bokhandeln.

Law, Sylvia. 1974. Blue cross: What went wrong? New Haven: Yale University Press.

Leavitt, Harold J. 1951. Some effects of certain communication patterns on group performance. Journal of Abnormal and Social Psychology. 46:38-50.

Lerner, Daniel. 1957. Communication systems and social systems: A statistical exploration in history and policy. Behavioral Science. 2:266-275.

Lerner, Daniel. 1958. The passing of traditional society. Glencoe, Illinois: The Free Press.

Lindsey, Almont. 1962. Socialized medicine in England and Wales: The National Health Service, 1948-1961. Chapel Hill: University of North Carolina Press.

McKeown, Thomas, R. G. Record, and R. D. Turner. 1975. An interpretation of the decline of mortality in England and Wales during the twentieth century. Population Studies. 29:391-422.

Mechanic, David. 1972. Public expectations and public health. New York: John Wiley and Sons.

Medicinalstyrelsen. Allman Halso-och Sjukvard ar 1917. Stockholm: Norstedt.

Medicinalstyrelsen. 1946. Allman Halso-och Sjukvard ar 1944. Stockholm: Norstedt.

Merton, Robert K. 1957. Social history and social structure. Glencoe, Illinois: The Free Press.

Meyer, John W. 1975. Convergence and divergence in development. Annual Review of Sociology. 1:223-246.

Mitchell, B. R. 1975. European historical statistics, 1750-1970. New York: Columbia University Press.

Moch, Michael. 1976. Structure and organizational resource allocation. Administrative Science Quarterly. 21:661-675.

Mohr, Lawrence. 1969. Determinants of innovation in organizations. American Political Science Review. 63:111-126.

Mulder, Maul. 1960. Communication structure, decision structure and group performance. Sociometry. 23:1-14.

Mytinger, R. E. 1968. Innovation in local health services. Washington, D.C.: U.S. Government Printing Office, Public Health Service Publication No. 1664-2.

Parish, H. J. 1968. Victory with vaccines: The story of immunization. Edinburgh: E and S Livingston, Ltd.

Parsons, Talcott. 1959. Essays in sociological theory: Pure and applied. New York: The Free Press of Glencoe.

Pelz, Donald G. and Frank M. Andrews. 1966. Scientists in organizations: Productive climates for research and development. New York: John Wiley and Sons.

Preston, Samuel H. 1976. Mortality patterns in national populations: With special reference to recorded causes of death. New York: Academic Press.

Pye, Lucien. 1962. Politics, personality, and nation building. New Haven: Yale University Press.

Rogers, Everett M. 1962. Diffusion of innovations. New York: The Free Press.

Rokkan, Stein. 1970. Citizens, elections, parties. New York: McKay.

Rosen, George. 1964. The bacteriological, immunological and chemotherapeutic period, 1975-1950. Bulletin of the New York Academy of Medicine. 42:483-494.

Rosen, George. 1958. A history of public health. New York: M. D. Publications, Inc.

Rosenkrantz, Barbara. 1972. Public health and the state. Cambridge, Mass.: Harvard University Press.

Shepard, Herbert A. 1967. Innovation--Resisting and innovations producing organizations. Journal of Business. 40:470-477.

Socialstyrelsen. 1952. Social Sweden. Stockholm: Gernandts Baktrycker.

Somit, Albert and Joseph Tanenhaus. 1967. The development of political science. Boston: Allyn and Bacon, Inc.

Stevens, Rosemary. 1971. American medicine and the public interest. New Haven: Yale University Press.

Stevens, Rosemary. 1966. Medical practice in modern England: The impact of specialization and state medicine. New Haven: Yale University Press.

Top, Franklin H. and Paul F. Wehrle. 1976. Communicable and infectious diseases. St. Louis, Mo.: The C. V. Mosby Co.

Veney, James E. 1973. Attributes of health services as factors in program implementation. Journal of Health and Social Behavior. 14:124-133.

Walker, Jack L. 1969. The diffusion of innovations among the American states. American Political Science Review. 63:880-899.

Walker, Jack. 1971. Innovation in state politics. In Herbert Jacobs and Kenneth Vines, eds., Politics in the American states: A comparative analysis, 2nd edition. Boston: Little, Brown and Co.

Ward, Richard A. 1975. The economics of health resources. Reading, Mass.: Addison-Wesley Publishing Co.

Wilson, James Q. 1966. Innovation in organization: Notes toward a theory. In James D. Thompson, ed., Approaches to organizational design. Pittsburgh: University of Pittsburgh Press.

Youmans, Guy P., Philip Y. Paterson and Herbert M. Sommers. 1975. The biologic and clinical basis of infectious diseases. Philadelphia: W. B. Saunders.

Zaltman, Gerald, Robert Duncan and Jonny Holbek. 1973. Innovations and organizations. New York: John Wiley and Sons.